Linda S. Adams
Secretary for Environmental Protection

California Regional Water Quality Control Board
Central Valley Region
Katherine Hart, Chair

11020 Sun Center Drive #200, Rancho Cordova, California 95670-6114
Phone (916) 464-3291 • FAX (916) 464-4645
http://www.waterboards.ca.gov/centralvalley

Arnold Schwarzenegger
Governor

Field Testing for Total and Un-ionized Ammonia Nitrogen Using a Test Strip

19 May 2010

Why Does the General Order Require Field Testing for Total and Un-ionized Ammonia-Nitrogen?

Fish pull oxygen and other gases from water through their gills to breathe. When dissolved ammonia gas (Un-ionized Ammonia Nitrogen) gets into waterways, the fish pull the ammonia gas through their gills. Depending on the concentration of ammonia gas dissolved in the water, the fish can become very sick, or if the concentration is high enough, can die. Ammonia is a colorless substance that can accumulate in animal waste and any water that may come into contact with that waste.

The concentration of ammonia gas dissolved in the water, Un-ionized Ammonia Nitrogen, can be calculated by measuring:

1. Temperature
2. Total Ammonia-Nitrogen using a test strip
3. pH

When Does the General Order Require Field Testing for Total and Un-ionized Ammonia-Nitrogen?

The General Order requires field testing for Total and Un-ionized Ammonia-Nitrogen under the following circumstances:

1. Discharges of storm water from the Production Area to surface water – required daily
2. Discharges of storm water from 1/3 of the Land Application Areas – required once during the **first** storm event of the wet season and once **during the rainy season** (during a significant storm event)
3. Discharges of tailwater from each Land Application Area to surface water **if** you are irrigating with fresh water **and** it has been less than 60 days since manure or wastewater has been applied to the area – required for each discharge

For more detail about field testing requirements, see pages MRP-5 and MRP-6 of the General Order.

How Do I Do a Field Test for Total and Un-ionized Ammonia-Nitrogen?

You can test directly for Total Ammonia-Nitrogen by use of a test strip. You can then calculate Un-ionized Ammonia-Nitrogen using the Total Ammonia-Nitrogen data and field measurements

of pH and temperature. This method gives an approximate measurement of Total and Un-ionized Ammonia-Nitrogen.

Materials Needed:

1. Total Ammonia-Nitrogen measuring kit (test strips and test tubes)
2. Sample containers
3. Temperature measuring device
4. pH measuring device
5. Record book and pen for noting sample data

Follow the directions of the particular brand of test strips purchased. The general procedure is as follows (independent of brand):

1. Pour sample into test tube container.
2. Dip the test strip into the sample for the suggested time (5-30 seconds). The time the strip will be in the samples varies by brand of test strip.
3. Remove the test strip from the sample and wait the suggested time before comparing the test strip color to the color scale on the package container.
4. Note the amount. This is your approximate Total Ammonia-Nitrogen concentration.
5. Measure the temperature of the sample in the field at the time of sampling.
6. Measure the pH of the sample in the field at the time of sampling.
7. Use the colored table that corresponds to your approximate Total Ammonia-Nitrogen concentration to determine the approximate Un-ionized Ammonia-Nitrogen concentration based on your field measurement of pH and temperature

Note: If the Total Ammonia-Nitrogen concentration in your sample is greater than 6.0 ppm on the test strip scale, you can assume that the Un-ionized Ammonia-Nitrogen concentration is high enough to be a threat to water quality. Note the Total Ammonia-Nitrogen concentration in your record book as “greater than 6.0 ppm”.

Calculation Example

Step 1: Measure Total Ammonia-Nitrogen using test strip: measured 1.0 mg/l. This is your approximate Total Ammonia-Nitrogen and you would report 1.0 mg/l.

Step 2: Measure sample temperature: measured 40° Fahrenheit (4.5° Celsius0.

Step 3: Measure sample pH: measured 8.0.

Step 4: Use the “1 mg/l” colored table. On the 1mg/l table, 40^{o} F and 8.0 pH intersect in the blue box that says “0.01”. This is your approximate Un-ionized Ammonia-Nitrogen and you would report 0.01 mg/l.

Note: The colored tables show temperature in degrees Celsius on the left hand side and in degrees Fahrenheit on the right hand side.

What Do I Do with the Sampling Results?

First, look at the color of the box that contains your sampling result for Un-ionized Ammonia-Nitrogen. If the box is blue, the concentration of Un-ionized Ammonia-Nitrogen is low and should not affect most aquatic life. If the box is yellow, the Un-ionized Ammonia-Nitrogen concentration is medium and could affect aquatic life. You should evaluate what is happening at your dairy to cause the Un-ionized Ammonia-Nitrogen level to be so high. If the box is brown, the concentration of Un-ionized Ammonia-Nitrogen is high and is considered deleterious to many aquatic organisms. STOP THE DISCHARGE IMMEDIATELY and evaluate your operations to determine what is causing the high levels.

Keep a copy of all your sampling results (including the date and time of the sampling) with other records at your dairy. Be prepared to show the results to a Regional Board staff person during a site inspection or to send a copy of the results to the Regional Board if you receive a written request to do so

Comments on Total Ammonia-Nitrogen Test Strips:

1. Total Ammonia-Nitrogen test strips can be purchased at major aquarium supply stores or online. The charts are set up for test strips reading 0.25, 0.5, 1.0, 3.0, and 6.0 mg/l Total Ammonia-Nitrogen.
2. Several brands of test strips have been evaluated by staff. All brands tested gave consistent results; Hach brand strips were easiest to use. A package containing 25 test strips and several test tubes should cost about $20.
3. It is very important that strips be fresh and that unused strips be kept in their container until used. Strips older than the expiration date on the bottle should not be used.
4. Although test strips are useful as a tool to evaluate field and facility run-off, they are not accurate enough for use in nutrient management applications.

UN-IONIZED AMMONIA LOOK-UP TABLES

For NH_3-N between 0.25 and 6.0 mg/L (ppm)

(Only to be used as a field tool, not intended to be used as an absolute guide to determine if the water will be deleterious. Laboratory analysis and additional parameters are required to determine the regulatory level).

Instructions:

If you have a field test for Total Ammonia:

1) Determine the Total Ammonia Nitrogen (TAN) of the sample, reported as (NH_3-N).
2) Determine the pH (to one decimal minimum) and temperature of the sample immediately at the time the sample is taken.
3) Use the tables to determine the un-ionized ammonia (NH_3).

If you are using a lab report:

1) The pH and temperature must be determined immediately when the sample is taken.
2) When the lab sample results are received, use the Total Ammonia reported as NH_3-N and the tables to determine the un-ionized ammonia present at the time the sample was taken.

Results:

0.0 - 0.019 - LOW

0.02 - 0.039 - MED. To maintain a healthy aquatic life in freshwater, the Ca Dept. of Fish and Game has determined the ammonia (as un-ionized) should not exceed 0.02 mg/L. May be considered deleterious depending on other existing conditions.

0.04 plus - HIGH Considered deleterious to many aquatic organisms. Acute toxicity (96-hr LC50) of ammonia to various freshwater fish ranges from 0.1 to 4 mg/L. (McKee and Wolf 1971)

6 mg/L (ppm) Total Ammonia (NH_3-N)

pH

Temperature in Degrees C	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	Temperature in Degrees F
4.0	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	39
4.5	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	40
5.0	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	41
5.5	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	42
6.0	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	43
6.5	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	44
7.0	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	45
7.5	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.06	46
8.0	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	46
8.5	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	47
9.0	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	48
9.5	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	49
10.0	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07	50
10.5	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.06	0.07	51
11.0	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	52
11.5	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.08	53
12.0	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.08	54
12.5	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07	0.08	55
13.0	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07	0.09	55
13.5	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.06	0.07	0.09	56
14.0	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09	57
14.5	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.08	0.10	58
15.0	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.08	0.10	59
15.5	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07	0.08	0.10	60
16.0	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07	0.08	0.11	61
16.5	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.06	0.07	0.09	0.11	62
17.0	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09	0.11	63
17.5	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.08	0.09	0.12	64
18.0	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.08	0.10	0.12	64

3 mg/L (ppm) Total Ammonia (NH_3-N)

pH

6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8
0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03
0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03
0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03
0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03
0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03
0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03
0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03
0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04
0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04
0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05
0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05
0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05
0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05
0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05
0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.06
0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06
0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06
0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06
0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06
0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.06	0.07
0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07
0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07
0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.08

Example 1: Stormwater sampled has a temperature of 50 degrees F and a pH of 7.4 (pH measured to the tenth minimum). The field test for Total Ammonia is 4 mg/L. Use the 4 mg/L table. This would be 0.02 mg/L un-ionized ammonia. You should evaluate and correct what is causing the elevated ammonia levels.

Example 2: Runoff is 60 degrees F and the pH is 7.6. The field test for Total Ammonia is 6 mg/L. Use the 6 mg/L table. The un-ionized ammonia is 0.08 mg/L. Shut the discharge off and evaluate what is causing the elevated ammonia.

1 mg/L (ppm) Total Ammonia (NH_3-N)

pH

Temperature in Degrees C	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5
4.0	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04
4.5	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04
5.0	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05
5.5	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05
6.0	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05
6.5	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05
7.0	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.05
7.5	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.06
8.0	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06
8.5	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06
9.0	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06
9.5	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07
10.0	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07
10.5	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07
11.0	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.07
11.5	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.08
12.0	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.08
12.5	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07	0.08
13.0	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07	0.08
13.5	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09
14.0	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09
14.5	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.08	0.09
15.0	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.08	0.10
15.5	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07	0.08	0.10
16.0	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07	0.08	0.10
16.5	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09	0.11
17.0	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09	0.11
17.5	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.08	0.09	0.12
18.0	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.08	0.10	0.12

0.5 mg/L (ppm) Total Ammonia (NH_3-N)

pH

7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	Temperature in Degrees F
0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	39
0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	40
0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.04	41
0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	42
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	43
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	44
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	45
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	46
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.06	46
0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	47
0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	48
0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	49
0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	50
0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.06	0.07	51
0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.07	52
0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.07	53
0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.07	54
0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.08	55
0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.08	55
0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.07	0.08	56
0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.05	0.07	0.08	57
0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09	58
0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.09	59
0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.08	0.09	60
0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.08	0.10	61
0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.07	0.08	0.10	62
0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.10	63
0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09	0.10	64
0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.09	0.11	64

0.25 mg/L (ppm) Total Ammonia (NH_3-N)

pH

7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8
0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02
0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02
0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02
0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02
0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03
0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03
0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03
0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03
0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03
0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03
0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03
0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03
0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03
0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04
0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04
0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04
0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04
0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04
0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.04
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05
0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05
0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.04	0.05
0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.04	0.05

Note - These tables are intended for field management purposes. They are to be used as a tool to help evaluate the nature of field and facility runoff and prevent off-property discharges of deleterious levels of ammonia. They can also be used for general facility and waste management practices. Due to the dynamic nature of discharge events, these table are not to be used for enforcement purposes.

References - Emmerson, K. et. al.. 1975. Aqueous Ammonia Equilibrium Calculation: Effect of pH and Temperature. Journal of the Fisheries Research Board of Canada., Vol.32(12):2379-2383.